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THE 1976 ACCIDENT EXPERIENCE OF CIVILIAN PILOTS WITH STATIC PHY--ETC(U)  
AUG 79 J R DILLE , C F BOOZE  
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13. Sponsoring Agency Name and Address Office of Aviation Medicine Federal Aviation Administration 800 Independence Avenue, S.W. Washington, D.C. 20591	14. Sponsoring Agency Code	15. Supplementary Notes <b>12</b> 9
16. Abstract The 1974 and 1975 aircraft accident experiences of civilian pilots with eight selected static physical defects have been examined and reported previously. Three categories--blindness or absence of either eye, deficient color vision with a waiver, and deficient distant vision--had significantly more accidents than were expected on the basis of observed-to-expected ratios. However, pilots with these conditions reported considerably higher median 6-month flight times than did an active airman population sample and accident airmen without selected pathology. In 1975 the reported recent and total flying times for all airmen with these defects were determined and accident rates were calculated. The rates for airmen with blindness or absence of an eye were still found to be significantly higher. The contact lens group was also selected to receive special attention in a study of the 1976 accident data because marginal significance was found on analysis of the 1975 data and, after 1976, this group will not carry a pathology code or require a waiver and thus will be difficult to study.  Observed-to-expected ratios for 1976 are 1.91 for deficient color vision with a waiver, 1.28 for contact lens users, 1.37 for blindness or absence of either eye, and 1.62 for deficient distant vision. The accident rates per 100,000 hours of cumulative and last 6 months' flying experience were significantly greater for contact lens users and monocular pilots than for the active airman population. The other groups had no consistently significant differences. Each accident was reviewed to determine time of day, phase of flight, weather conditions, and recent flight experience in an attempt to determine bases for the findings. None was found.		
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## THE 1976 ACCIDENT EXPERIENCE OF CIVILIAN PILOTS WITH STATIC PHYSICAL DEFECTS

### I. Introduction.

The 1974 and 1975 aircraft accident experiences of civilian pilots with eight selected static physical defects have been examined and reported previously (1,2). These conditions were blindness or absence of either eye, use of contact lenses, deficient color vision with a statement of demonstrated ability (waiver) and no operational limitations, deficient color vision with a restriction "not valid for night flight or color signal control," deficient distant vision, paraplegia, deafness, and amputations. For each category we determined the number in the active airman population, the rate per 1,000 airmen, the expected number of accident airmen on a ratio basis to total airmen and total accidents, the observed accident airmen, the observed-to-expected accident airman ratio, and the statistical significance by the chi-square test. Three groups--blindness or absence of either eye, deficient color vision with a waiver, and deficient distant vision--had significantly more accidents than were expected on the basis of observed-to-expected ratios. In 1974, pilots with these three conditions reported considerably higher (4- to 8-fold) median 6-month flight times in the 6 months preceding their most recent physical examinations before their accidents than did an active airman population sample, but the study was not designed to determine the role of exposure by calculation of accident rates.

In 1975 the same three categories plus the contact lens group had more accidents than were expected as demonstrated by the observed-to-expected ratio. This year the self-reported 6-month and total flying times for all airmen and all airmen with the three defects significant in 1974 were determined and accident rates were calculated. The rates for airmen with blindness or absence of an eye were found to be significantly higher than the total active airman population. The rates for airmen with deficient distant vision and deficient color vision and a waiver were not significant when the 6-month flying times were used; the rate for the color vision group using total time was significantly higher but was felt to be of marginal importance considering the 6-month rate.

Individual accident records were reviewed to determine any possible relationship between visual defects of the pilot and accident cause, phase of flight, type of flying, time of day, and weather but no unusual associations were determined.

The contact lens group was selected to receive special attention in a study of the 1976 data because a marginal significance was found in the analysis of the 1975 accidents and, after 1976, this group will not carry a pathology code or require a waiver and thus will be very difficult to study.



## II. Method.

For the 1976 active airman population of 780,408, the numbers were determined who had blindness or absence of either eye (includes uncorrectable distant visual acuity of 20/200 or worse in one eye); contact lenses; deficient color vision but who had taken and passed a signal light gun test and had no operational limitation; and deficient distant vision (uncorrected distant vision poorer than 20/100 for first and second class, or does not correct to standards for any class). The deficient distant vision category ordinarily includes many who also have absence of an eye and some who wear contact lenses, but these were subtracted for this study.

For each of these four categories, their representation per 1,000 active airmen, expected frequencies for 4,355 total accidents, actual accident experience, ratio of observed to expected accidents, and significance by the chi-square test were calculated.

Total and last-6-months civilian flight hours, reported at the time of the most recent physical examinations, were obtained for all active airmen, those with blindness or absence of either eye, those with deficient distant vision, those with deficient color vision, and those who wear contact lenses. From these flight time data, accident rates per 100,000 hours of flying experience, both total and in the last 6 months, were calculated and statistically compared.

Finally, the records for all accidents involving pilots in one of these four defect categories were reviewed by the authors to determine if medical conditions had been considered by the accident investigators or if time of day, phase of flight, nature of the accident, or other findings offered any plausible explanation for the accident experience of these groups.

## III. Results.

The numbers of active airmen in each of the four categories and their accident experience in 1976 are shown in Table 1. The 1974 and 1975 data are included for comparison. Again, the same four categories had more than their expected numbers of accidents--deficient color vision with no restriction, deficient distant vision, blindness or absence of either eye, and contact lens use.

When the accident experiences of airmen with each of the four static defects of major concern were compared with the total active airman population accident experience per unit of total (cumulative) and recent (6 months) exposure (Table 2), both rates for airmen with blindness or absence of an eye were again found to be significantly higher as were those for the contact lens group, the rates for those with deficient color vision were again significant when total experience was used but not significant when calculated for recent exposure. Similar findings to those for color vision were observed for the deficient distant vision category.

Review of each of the accidents and extraction of factors of interest and concern did not reveal any unusual associations of these accidents with weather, time of day, mid-air collisions, or agricultural flying. Physical findings had not been ascribed causal roles. Landing accidents, which usually account for about 40 percent of the total, were listed in our preliminary tabulation as the phase for 89 percent of the monocular pilot accidents. However, after review of the reports for the correct phase and adjustment for emergency landings reportedly caused by mechanical problems, the final figure was 41 percent (15 of 37). Of these, two struck objects (power line, trees) on approach, one misjudged snow depth, two landed left or right of the runway, four ran off the end of the runway (one on a downwind landing), two lost directional control, and one accident was blamed on a downdraft. Most of the 15 were pilot factor accidents but not definitely associated with their visual problems. Binocular pilots have similar accidents. Some of the accidents with "loss of power" and other cited mechanical problems could also have been due to human factors; mechanical problems can be caused by human errors and loss of power is an easy excuse for landing short.

When the medical records of 36 "monocular" pilots with the 37 accidents were reviewed, we were surprised to learn that 3 had been miscoded and 5 who were originally correctly coded were subsequently reported as having better than 20/200 corrected visual acuity in their "bad" eye.

No corrections to the tables and calculations have been made as a result of this finding. We assume that the errors and variations apply equally to the 37 accident airmen and to the 4,855 total "monocular" airmen groups. The ratios and rates which we have calculated here are, by definition, estimates and we feel that they are still best estimates. We do not have sufficient resources or priority to review all 4,855 medical records at this time.

Of the 36 monocular airmen who had accidents, 18 had no useful vision in one eye, 9 had best corrected vision of 20/200 or worse in one eye, 5 had previous visual recordings which caused correct assignment of a monocular code but do not presently meet the criteria, the record cannot be located for one, and 3 never should have been coded as monocular. One of the non-monocular pilots had two accidents in 1976.

Six of the 37 accidents were fatal; 2 of these 6 pilots did not meet the monocular criteria at the time of their accidents.

No unusual associations were found with phase of flight, accident cause, weather, time of day, or recency of experience for the contact lens, deficient distant vision, or deficient color vision groups, either.

#### IV. Conclusions.

Despite the recent discovery of errors and variations in the assignment of the code for monocularity, the increased accident ratios and rates for monocular pilots, which have been observed for 3 consecutive years, are felt to be real. However, there is no clear indication at this point of the exact

nature of the problem or how to avoid it. No changes in medical standards or policies are proposed at this time. Studies have shown normal performance by binocular pilots suddenly rendered monocular (3,4,5) so no further research is recommended, either, for now.

We do suggest greater awareness of these findings and our concern, increased knowledge about depth perception, and recognition of the disadvantages of monocularity by flight instructors, physicians, affected airmen, and accident investigators.

At a recent staff seminar, 15 visual cues for depth perception were identified. Only two (stereopsis and convergence) are binocular, the other 13 are monocular including retinal size, which is better than stereopsis, and motion parallax, which is also very effective. However, with monocularity there is 1) no spare, 2) possible incapacitation by a foreign body, 3) a reduced field of vision, 4) an uncompensated blind spot, 5) increased awareness of floaters, and, perhaps most important, 6) frequent denial by the individual.

The variable classification of many pilots as monocular, which has complicated the analysis herein, can probably be attributed to the frequent imprecise measurement of acuities of 20/100 or worse. A case which varied from 20/400 to 20/13 uncorrected probably involved undetected contact lenses. Improved accuracy will be stressed for Aviation Medical Examiners. There is some regret that administrative monocularity is combined with actual monocularity in our data base and that refractive error information is not obtained.



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TABLE 1. Airmen and Accident Frequencies for Selected Pathology Categories

Pathology Category		Freq. Active Airmen Pop.	Rate/ 1,000	Expected Accident Airmen	Observed Accident Airmen	No. Observed		Chi- Square Test
						No.	Expected	
Contact Lenses	(1976)	17,657	22.62	98.5	126.0	1.28		7.8***
	(1975)	15,737	20.60	86.1	104.0	1.21		3.80**
	(1974)	14,421	18.91	87.0	99.0	1.14		1.70*
Blindness or Ab- sence of Either Eye	(1976)	4,855	6.22	27.1	37.0	1.37		3.67**
	(1975)	4,781	6.26	26.2	35.0	1.34		3.01**
	(1974)	4,704	6.17	28.4	45.0	1.58		9.86***
Deficient Distant Vision	(1976)	21,909	28.10	122.3	198.0	1.62		16.50****
	(1975)	21,464	28.10	117.5	145.0	1.23		6.66***
	(1974)	20,247	26.55	122.1	165.0	1.35		15.55****
Deficient Color Vision-No Restriction	(1976)	6,861	8.79	38.3	73.0	1.91		31.93****
	(1975)	5,690	7.45	31.1	61.0	1.96		28.99****
	(1974)	5,157	6.76	31.1	52.0	1.67		14.21****

\*Not significant at .10    \*\*Significant at .10    \*\*\*Significant at .01    \*\*\*\*Significant at .001

TABLE 2. Accident Rates Per 100,000 Hours of Civilian Flight Time for Selected Static Defect Groups

Defect	Civilian Flight Hours	
	Last 6 Months	Cumulative to Date
Contact Lenses	15.3**	0.9**
Blindness or Absence of Either Eye	20.0**	0.7**
Deficient Distant Vision	12.1*	0.5**
Deficient Color Vision	13.9*	0.7**
Total Active Airman Population	11.2	0.4

\*Not significant

\*\*Significant at 0.05